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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: JACK FRIDTHJOF

FOR: A DEVICE FOR DETECTION OF SURFACE CONDITION DATA

CLAIM FOR PRIORITY UNDER 35 U.S.C. 119

The Commissioner of Patents
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Alexandria, VA 22313-1450

Dear Sir:

Applicant hereby claims the benefit of the filing date of 14 March 2003 of Danish Patent Application No. PA 2003 00386 under the provisions of 35 U.S.C. 119 and the International Convention for the Protection of Industrial Property.

If any fees are due with regard to this claim for priority, please charge them to Deposit Account No. 06-1130 maintained by Applicant's attorneys.

Respectfully submitted,

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Title: A device for detection of road surface property data and distribution thereof.

IPC: -

This is to certify that the attached documents are exact copies of the above mentioned patent application as originally filed.

Patent- og Varemærkestyrelsen
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07 April 2004

John Nielsen

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DANSK PATENTANSØGNING

Titel:

A DEVICE FOR DETECTION OF ROAD SURFACE PROPERTY DATA AND DISTRIBUTION THEREOF

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A DEVICE FOR DETECTION OF ROAD SURFACE PROPERTY DATA AND DISTRIBUTION THEREOF

The present invention relates to detection of road surface properties, in particular detection of water, snow and ice, by means of detector means mounted on individual vehicles. The detected properties are according to the invention transmitted form the vehicle, preferably together with position data of the vehicle, to be used by drivers of other vehicles for warning of slippery road conditions ahead of the vehicle.

BACKGROUND

Detectors for determining the properties of a road surface are well known in the art, including stationary detectors arranged along the roadside and above the surface, detectors arranged beneath the road surface and detectors arranged on the vehicles.

A simple principle for contact-less measurement is disclosed in US 4,274,091 by Decker, in which a series of light pulses is directed towards the road surface by a light emitter with a chopper wheel, and the intensity of the reflected light is measured with one receiver. The amplitude of the signal measured by the receiver indicates the presence or absence of ice on the road surface.

Another principle is disclosed in US 4,690,553 by Fukamizu et al., in which an infrared light emitter directs a ray towards the road surface, and two receivers are arranged to measure the reflected light and the scattered light, respectively. The ratio of the output from the two receivers provides information of the road surface properties. Utilisation of the reflection of infrared light to measure the road surface properties is also known from e.g. DE 2,712,199, EP 0,005,696 and DE 3,023,444.

Other principles involves the use of acoustic waves as disclosed in Japanese patent application JP 03-110408 by Hiroshi and Masami, The use of microwaves is disclosed e.g. in US 5,652,522 by Kates and Butler and in US 3,836,846 by Overall and deKoning, the use of microwaves in combination with a laser light beam as

disclosed in Japanese patent application JP 06-307838 by Takaharu, the use of multiple wavelength regions of infrared light is disclosed in US 5,218,206 and in US 5,962,853.

All the disclosed measurement principles and other similar principles may be utilised for the device and the system of the present invention. The different arrangements of the sensors have each their drawback. Sensors arranged along the roadside and above the road surface have to be about 4.5 meters above to road surface to allow all types of vehicles to pass, and the air between the sensor and the road surface will be contaminated with particles raised from the road surface by the passing vehicles, in particular when the road surface is wet or covered with sled or snow, and the reliability of the sensor is therefore low under the weather conditions at which the warnings of slippery surface conditions are of importance. Sensors embedded in the road surface and measuring the properties thereof from below through a transparent lid, suffer from contamination of the upper surface of the lid and development of scratches, which ruin the operation of the sensor. Sensors mounted on the vehicle measure from above close to the road surface, but provide only information about the road surface properties at the position of the vehicle, which often is too late for the driver of the vehicle to take measures, in particular under changing properties of the road surfaces and during weather conditions where only local areas of the road surfaces have slippery conditions.

Thus, it is an object of the present invention to provide a devise for determining the properties of the road surface with high reliability under the relevant weather conditions and providing the relevant data to the drivers of the vehicles before they enter the area where the properties are determined.

This object is achieved by the present invention by equipping vehicles with road surface sensor device for mounting in a vehicle, comprising detector means for contact-less detection of the surface properties of the road surface and providing an output accordingly as discussed above, where the device further comprises

transmission means for receiving said output from the detector means and performing a wireless transmission of road surface property data based thereon to a receiver exterior to the vehicle. The receiver may e.g. be similar devices in other vehicles or a common system that distribute the data to drivers of other vehicles by means of similar devices having a receiver, by roadside visual communication devices and/or by radio broadcast, such as the Radio Data System – Traffic Message Channel (RDS-TMC).

With this solution, a system of a plurality of mobile sensors may be provided which are arranged very close to the part of the road surface on which the vehicles drive, and they may therefore determine the relevant properties of the road surface from the most advantageous position. These very reliable data are transmitted and received, so that the system as a whole holds reliable data for at least a part of the road surfaces of an area and may distribute these data to the drivers of the vehicles before they enter the area where the data were determined.

Other advantages of the present invention, preferred embodiments and refinements thereof and the associated advantages are disclosed below.

BRIEF DESCRIPTION OF THE INVENTION

Thus, the present invention relates to a road surface sensor device for mounting in a vehicle, comprising detector means having a radiation transmitter directed to the road surface and at least one receiver for receiving the radiation returned from the road surface and providing an output accordingly, and data processing means for processing the output from the at least one receiver to determine surface properties of the road and providing an output accordingly, wherein the device comprises transmission means for receiving said output from the detector means and conducting a wireless transmission of road surface property data based thereon to a receiver exterior to the vehicle.

The radiation may, as discussed previously, be sonic or electromagnetic or a combination thereof, and it is preferred that radiation in the infrared range is used, as the reflection and scattering of infrared light is particularly sensitive to the occurrence of ice particles. Another preferred embodiment includes a plurality of receivers, such as a linear or two-dimensional CCD (Charge-Coupled Device) camera or other camera device, where the pattern of the output from the receivers is analysed.

The transmitter may be any type of radio based transmitter, but it is preferred to use a public wireless data communication network as the ones used for cellular telephones and data transmission, such as the GSM (Global System for Mobile Communications) or GPRS (General Packet Radio Service).

The device will, together with devices in one or more vehicles on the same road or in the same area or stationary device constitute a network for collection and distribution of road surface property data, and the quality of the output from the network will be improved for each extra participant. It is also important to notice that the collection of data is continuous and that useful data are collected from devices in vehicles that are moving slowly or are at a stand still, which is often the situation when the roads are slippery.

It is preferred that the device comprises position means for generating position data for estimation of the current position of the device, and that the transmission means is arranged to transmit said position data. Thereby, the coupling of the road surface property data and the position data may be made immediately. Another use of the position data is to filter data from other devices of the system to obtain data relevant to receive and display for the individual device. This filtering may take place locally in the device itself, which e.g. receives data from all similar devices, or the filtering may be performed centrally based on position data received from the devices. Furthermore, it is also preferred that the time of determining the road surface property data are generated and associated with said data.

The position means may be one of a number of different known position determining means, such as means for generating said position data from communication with a wireless data communication network constituted by a plurality of stationary transceiver stations. Another known position determining means comprises means for satellite based position estimation such as the GPS (Global Positioning System). Alternatively, the position may be determined by a system exterior to the device, e.g. based on triangulation from a number of transceiver stations of a wireless data transmission network.

The transmitted data from the device may be received and used in various different ways as discussed previously. However, it is preferred that the device comprises wireless receiver means and data output means for receiving an input from said receiver means and presenting an output perceivable by the driver of the vehicle based thereon. The receiver means may receive data from other, similar devices or from a central, stationary transmitter that receives and transmits data from a plurality of such devices. Another advantage of including a wireless receiver means is that the device and the system may be employed to transmit information from e.g. the police authorities or the road authorities to the drivers of the vehicles, preferably in a particular area or driving towards a particular road section. The driver will also receive the relevant information from the network even if the device of the vehicle is out of order or too clogged with dirt to function correctly.

The data output means may further be arranged for receiving an input from the detector means and presenting an output perceivable by the driver of the vehicle based thereon.

A further feature of the device is preferably that the transmission means of the device are adapted to transmit operational data of the vehicle, such as indication of an emergency breaking, output from an antilock braking system (ABS) of the vehicle and/or the output from an accelerometer of the vehicle. The purpose is to provide

warnings to other drivers of operational conditions that indicate slippery conditions or emergency situations. A system for distributing data from the ABS or similar systems of the vehicles to other vehicles is disclosed in Japanese patent application JP 2001-107041 by Yukio and Hiroshi, and the disclosed system and many of the details thereof may be used as a supplement to the system of the present invention. However, as the system of JP 2001-107041 only provides signals when a wheel of a vehicle actually slips relatively to the road surface, it cannot replace the system of the present invention, which provides data of the actual condition of the road surface, regardless of whether the wheels of a vehicle have slipped on the surface or not and also from vehicle moving slowly or are stopped, as often occurs during periods with slippery road conditions.

The present invention relates furthermore to the system comprising a plurality of devices as disclosed above, each mounted in a separate vehicle, stationary receiver means for receiving wireless transmissions of road surface property data from said devices, means for associating said road surface property data with position data, and means for distributing the received data.

It is preferred that system comprises position determination means for determining the position of each of said devices. The position data may be obtained from the individual devices or may be obtained from a central system, e.g. from triangulation based on a number of transceiver stations of a wireless data transmission network. The triangulation may be performed from the devices in the vehicles or from the stationary system.

The means for distributing the received data may preferably comprise wireless data transmission means for transmitting the data to e.g. receivers in vehicles and/or to receivers in stationary signs arranged along the roads.

The means for distributing the received data may in one embodiment be adapted to distribute the associated position data together with the road surface property data

associated thereto, so that the filtering of the distributed data is performed at the receiving parts. The means for distributing the received data may additionally or alternatively be adapted to distribute data dedicated to receiver means of individual ones of said devices in accordance with position data of said individual devices.

The system may further comprise stationary detector means arranged along the roads for contact-less detection of the surface properties of the road surface and providing an output accordingly, the output being distributed by the distribution means similarly to the received data.

The means for distributing the received data comprises a plurality of visual communication devices, i.e. signs with display means, arranged along roads for distributing information to the drives of vehicles on said roads based on the received road surface property data.

The present invention further relates to a road surface detector means to be mounted on a vehicle for contact-less detection of the surface properties of the road surface and providing an output accordingly, comprising a radiation transmitter directed to the road surface and at least one receiver for receiving the radiation returned from the road surface and providing an output accordingly, wherein the detector means comprises washing means for the transmitter and the at least one receiver for recurrently flushing thereof. This detector means may be used with the device and the system disclosed previously. The purpose of the washing means is to improve the reliability of the detector by removing dirt that prevents the transmitter and the receiver from operating at optimal visual contact with the road surface. The washing means may be actuated by a surveillance device that supervises the operation of the detector means. It is particularly preferred that said washing means is connected to and operates concurrently with a windshield washer system of the vehicle. Thereby, the driver of the vehicle functions as the surveillance device, as the windshield will be unclear to an extent and at a rate that is parallel to the same conditions for the detector means.

It is of importance to the credibility and reliability of the device that the output is provided substantially constantly, and it is preferred that the device comprises a self-check circuit that provides an "Out-of-order" output if the device is not operating properly. The output may be used to control the operation of separate washing means for flushing the transmitter and the at least one receiver recurrently.

Furthermore, the present invention relates to a road surface detector means to be mounted on a vehicle for contact-less detection of the surface properties of the road surface and providing an output accordingly, comprising a radiation transmitter directed to the road surface and at least one receiver for receiving the radiation returned from the road surface and providing an output accordingly, where at least one receiver of the detector means comprises a shutter device for allowing a temporal access of radiation to the receiver for a period of 1/10 to 1/50,000 seconds, preferably of 1/50 to 1/10,000 seconds. This detector means may be used with the device, the system and the detector means disclosed previously. The purpose of providing the receiver with a shutter device is to enhance the sharpness of the reflection and/or the scattering received from the road when the vehicle moves at high velocity. A similar enhancement of the sharpness is not achieved by pulsing the radiation transmitter as known in the art.

BRIEF DESCRIPTION OF THE DRAWING

An embodiment of the present invention is disclosed in the accompanying drawing for the purpose of exemplifying the present invention without thereby limiting the scope of the invention and the protection conferred.

Fig. 1 is a diagram of the system with a device in a vehicle and a central, stationary part, and

Fig. 2 shows a washing device.

DETAILED DESCRIPTION OF AN EMBODIMENT

The system shown in Fig 1. comprises a device 1 for mounting in a vehicle, comprising a standard GPS device 2 used e.g. for a navigation system, a display unit 3, which also may be used for other purposes, e.g. for the navigation system, a radio 4 for receiving TMC, and a standard sensor device 5, communicating with the GPS device 2 and the display unit 3 via a wireless Bluetooth data connection 6. The standard sensor device 5 may also be used at stationary roadside measurement stations 5'. A radio transmitter 7 of the standard sensor device 5 communicates road surface property data achieved from the road surface detector means 8, from the GPS device 2 and other possible sources 9, such as the ABS, to the stationary part 10 of the system.

The stationary part 10 includes a central unit 11 that receives data from the devices 1 in vehicles, from stationary devices 5' and from various sources, 12, such as the police department and the meteorological institution providing whether forecasts. The data are distributed to a plurality of users 13, such as roadside signs, radio receivers 4 in vehicles, an Internet home page, etc.

Alternatives may be used for the different parts of the system as described previously. The GPS device 2 may be replaced by a position estimation system based on the radio transmitter 7 and triangulation from a plurality of transceiver stations constituting a data communication system with which the radio transmitter 7 communicates. The triangulation may be performed from the device 1 or from the stationary part 10 of the system. Another alternative for estimating the position is to perform a short-range radio communication between the device 1 and a plurality of stationary stations arranged along the roadside, e.g. equipped with signs for providing alerts to the drives of the passing vehicles of ice on the road surface ahead. This short-range communication may be used to communicate road surface property

data to the stationary system and simultaneous provide information about the position of the vehicle when the data were obtained.

The radio 4 which is used to receive road surface property data from the stationary part 10 of the system may be replaced by a radio receiver, e.g. a mobile phone device, which constantly receives road property data transmitted either from other devices of other vehicles or from a stationary system, and filter the data based on the position data included in the received data and vehicle position data received from the position estimation system of the device. Alternatively, the road surface property data may be filtered at the stationary part 10 of the system based on vehicle position data received from the device 1 and only the relevant road surface property data are transmitted with a unique user identification to the device 1, where a receiver filter the received data based on the user identification included in the received data. The received, relevant data is then presented to the driver, preferably by means of the display unit 3 and/or an audio signal in case the road condition requires a warning to the driver.

A road surface detector means 8 mounted on a vehicle for contact-less detection of the surface properties of the road surface and providing an output accordingly is shown in Fig. 2. The detector means 8 comprises a radiation transmitter directed to the road surface and at least one receiver for receiving the radiation returned from the road surface and providing an output accordingly. The detector means 8 comprises washing means 14 for the transmitter and the at least one receiver for recurrently flushing thereof, comprising a Y-branch 15 in the tube 16 connecting the pump of the windshield washer system of the vehicle and the nozzles for distributing the cleaning liquid onto the windshield. A second tube 17 directs a part of this liquid to a nozzle 18 that flushes the detector means 8 every time the driver of the vehicle actuates the windshield washer system.

PATENT CLAIMS

1. A road surface sensor device for mounting in a vehicle, comprising

detector means having a radiation transmitter directed to the road surface and at least one receiver for receiving the radiation returned from the road surface and providing an output accordingly, and data processing means for processing the output from the at least one receiver to determine surface properties of the road and providing an output accordingly,

characterised in that

the device comprises transmission means for receiving said output from the detector means and conducting a wireless transmission of road surface property data based thereon to a receiver exterior to the vehicle.

2. A device according to claim 1, comprising

position means for generating position data for estimation of the current position of the device,

wherein the transmission means is arranged to transmit said position data.

3. A device according to any of the preceding claims, comprising

wireless receiver means, and

data output means for receiving an input from the receiver means and presenting an output perceivable by the driver of the vehicle based thereon.

4. A device according to claim 3, wherein the data output means further is arranged for receiving an input from the detector means and presenting an output perceivable by the driver of the vehicle based thereon.

5. A device according to claim 3 or 4, wherein the receiver means is adapted to receive radio transmissions of data from transmission means of devices similar to the device itself.

6. A device according to any of the preceding claims, wherein the transmission means are adapted to transmit operational data of the vehicle.

7. A device according to any of the preceding claims, comprising washing means for the transmitter and the at least one receiver for recurrently flushing thereof.

8. A device according to claim 7, wherein said washing means is connected to and operates concurrently with a windshield washer system of the vehicle.

9. A device according to any of the preceding claims, wherein at least one receiver of the detector means comprises a shutter device for allowing a temporal access of radiation to the receiver for a period of 1/10 to 1/50,000 seconds, preferably of 1/50 to 1/10,000 seconds.

10. A system comprising

a plurality of devices according to any of claims 1-9 each mounted in a separate vehicle,

stationary receiver means for receiving wireless transmissions of road surface property data from said devices,

means for associating said road surface property data with position data, and

means for distributing the received data.

11. A system according to claim 10, comprising position determination means for determining the position of each of said devices.

12. A system according to claim 10 or 11, wherein the means for distributing the received data comprises wireless data transmission means.

13. A system according to claim 10 or 11, wherein the means for distributing the received data is adapted to distribute the associated position data together with the road surface property data associated thereto.

14. A system according to any of claims 11-13, wherein the means for distributing the received data is adapted to distribute data dedicated to receiver means of individual ones of said devices in accordance with position data of said individual devices.

15. A system according to any of claims 10-14, further comprising stationary detector means for contact-less detection of the surface properties of the road surface and providing an output accordingly, the output being distributed by the distribution means similarly to the received data.

16. A system according to any of claims 10-15, wherein the means for distributing the received data comprises a plurality of visual communication devices arranged along roads for distributing information to the drives of vehicles on said roads based on the received road surface property data.

17. A road surface detector means to be mounted on a vehicle for contact-less detection of the surface properties of the road surface and providing an output accordingly, comprising a radiation transmitter directed to the road surface and at least one receiver for receiving the radiation returned from the road surface and providing an output accordingly,
characterised in that
the detector means comprises washing means for the transmitter and the at least one receiver for recurrently flushing thereof.

18. A detector means according to claim 17, wherein said washing means is connected to and operates concurrently with a windshield washer system of the vehicle.

19. A road surface detector means to be mounted on a vehicle for contact-less detection of the surface properties of the road surface and providing an output

accordingly, comprising a radiation transmitter directed to the road surface and at least one receiver for receiving the radiation returned from the road surface and providing an output accordingly,

characterised in that

at least one receiver of the detector means comprises a shutter device for allowing a temporal access of radiation to the receiver for a period of 1/10 to 1/50,000 seconds, preferably of 1/50 to 1/10,000 seconds.

ABSTRACT

A device and a system is disclosed for detection of road surface properties, in particular detection of water, snow and ice, by means of detector means mounted on individual vehicles. The detected properties are according to the invention transmitted form the vehicle, preferably together with position data of the vehicle, to be used by drivers of other vehicles for warning of slippery road conditions ahead of the vehicle.

With this solution, a system of a plurality of mobile sensors may be provided which are arranged very close to the part of the road surface on which the vehicles drive, and they may therefore determine the relevant properties of the road surface from the most advantageous position. These very reliable data are transmitted and received, so that the system as a whole holds reliable data for at least a part of the road surfaces of an area and may distribute these data to the drivers of the vehicles before they enter the area where the data were determined.

1/2

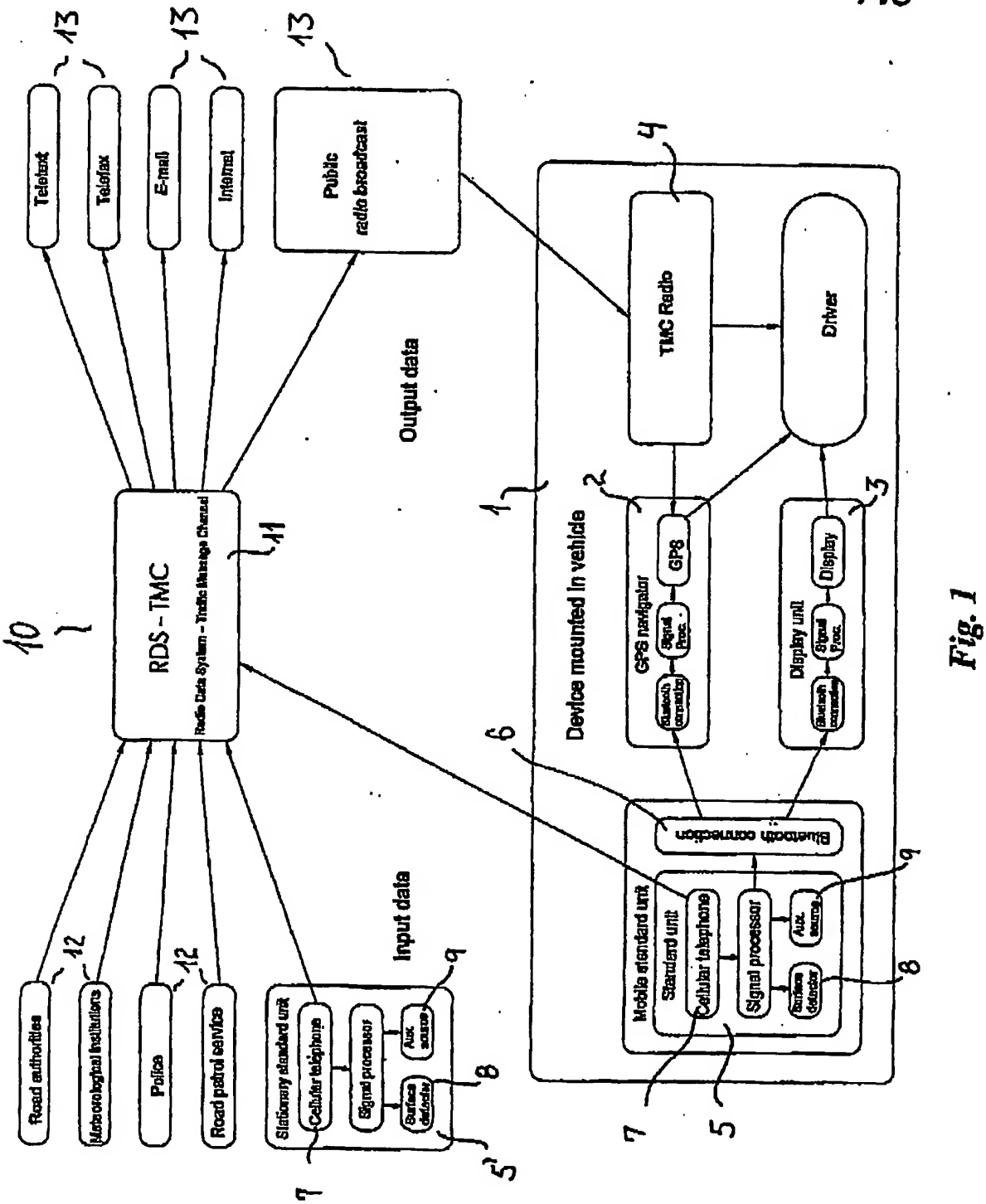

Fig. 1

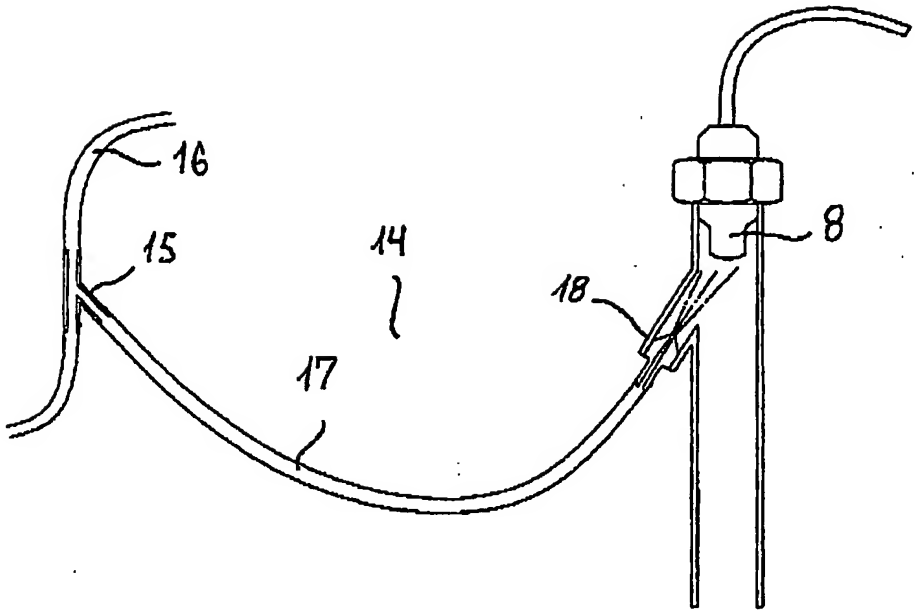

Fig. 2